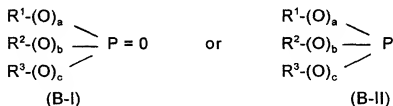


Claims

1. A lubricating oil composition, comprising:
  - (A) a base oil; and
  - (B) a phosphorus-containing compound represented by the formulae



wherein in Formulae (B-I) and (B-II), R<sup>1</sup>, R<sup>2</sup> and R<sup>3</sup> are independently hydrogen or hydrocarbyl groups, and a, b and c are independently zero or 1;

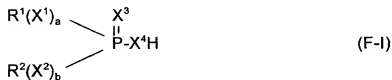
the lubricating oil composition being characterized by a sulfur content of about 0.01 to about 0.25% by weight.

2. The composition of claim 1 wherein the composition further comprises (C) an acylated nitrogen-containing compound having a substituent of at least about 10 aliphatic carbon atoms.

3. The composition of claim 1 wherein the composition further comprises (D) an alkali or alkaline earth metal salt of an organic sulfur acid, a carboxylic acid or a phenol.

4. The composition of claim 1 wherein the composition further comprises (E) an alkali or alkaline earth metal salt of a hydrocarbon-substituted saligenin.

5. The composition of claim 1 wherein the lubricating composition further comprises (F) a metal salt of a phosphorus-containing compound represented by the formula



10 wherein in Formula (F-I),  $X^1$ ,  $X^2$ ,  $X^3$  and  $X^4$  are independently O or S; a and b are independently zero or 1; and  $R^1$  and  $R^2$  are independently hydrocarbyl groups.

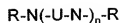
6. The composition of claim 1 wherein the lubricating oil composition further comprises (G) a dispersant viscosity index modifier.

15 7. The composition of claim 1 wherein in Formula (B-I),  $R^1$ ,  $R^2$  and  $R^3$  are independently aromatic or alkyl aromatic groups, and a, b and c are each 1.

20 8. The composition of claim 1 wherein (B) is a tri (alkylphenol) phosphate or a triphenyl phosphite.

25 9. The composition of claim 2 wherein the acylated nitrogen-containing compound (C) is derived from a carboxylic acylating agent and at least one amino compound containing at least one -NH- group, the acylating agent being linked to the amino compound through an imido, amido, amidine or salt linkage.

10. The composition of claim 9 wherein the amino compound is an alkyleneopolyamine represented by the formula:



wherein U is an alkylene group of from about 2 to about 10 carbon atoms; each R is independently a hydrogen atom, a hydrocarbyl group, a hydroxy-substituted hydrocarbyl group, or an amine-substituted hydrocarbyl group containing up to about 30 carbon atoms, with the proviso that at least one R is a hydrogen atom; and n is 1 to about 10.

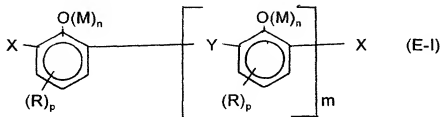
11. The composition of claim 2 wherein the acylated nitrogen-containing compound (C) is a polyisobutene substituted succinimide containing at least about 50 aliphatic carbon atoms in the polyisobutene group.

12. The composition of claim 3 wherein (D) is a neutral or basic alkali or alkaline earth metal sulfonate, carboxylate or phenate.

13. The composition of claim 3 wherein (D) is a neutral or basic alkali or alkaline earth metal salt of an aliphatic-hydrocarbon substituted salicylic acid or a lactone.

14. The composition of claim 3 wherein the alkali or alkaline earth metal in (D) is calcium or magnesium.

15. The composition of claim 4 wherein (E) is a compound represented by the formula



wherein in Formula (E-I): each X independently is -CHO or -CH<sub>2</sub>OH; each Y independently is -CH<sub>2</sub>- or -CH<sub>2</sub>OCH<sub>2</sub>-; wherein the -CHO groups comprise at least about 10 mole percent of the X and Y groups; each M is independently the valance of an alkali or alkaline earth metal ion; each R is independently a hydrocarblyl group containing 1 to about 60 carbon atoms; m is 0 to about 10; n is 0 or 1 provided that when n is 0 the M is replaced with H; and each p is independently 0, 1, 2, or 3; provided that at least one aromatic ring contains an R substituent and that the total number of carbon atoms in all R groups is at least 7; and further provided that if m is 1 or greater, then one of the X groups can be -H.

16. The composition of claim 5 wherein (F) is a zinc dialkyl dithiophosphate.

17. The composition of claim 6 wherein (G) is an olefin copolymer or an acrylate or methacrylate copolymer which is grafted with maleic anhydride and then derivatized with an alcohol or an amine.

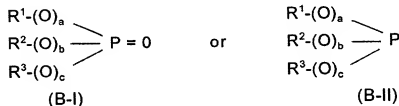
18. The composition of claim 1 wherein the lubricating oil composition further comprises at least one ashless detergent or dispersant, corrosion-inhibiting agent, antioxidant, viscosity modifier, pour point depressant, friction modifier, fluidity modifier, copper passivator or anti-foam agent.

19. A lubricating oil composition made by combining:

(A) a base oil;

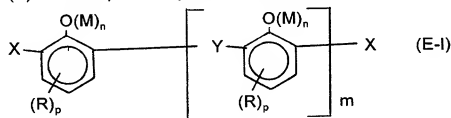
(B) a phosphorus-containing compound represented by the

formulae



wherein in Formulae (B-I) and (B-II), R<sup>1</sup>, R<sup>2</sup> and R<sup>3</sup> are independently hydrogen or hydrocarbyl groups, and a, b and c are independently zero or 1; and

(E) a compound represented by the formula



wherein in Formula (E-I): each X independently is -CHO or -CH<sub>2</sub>OH; each Y independently is -CH<sub>2</sub>- or -CH<sub>2</sub>OCH<sub>2</sub>-; wherein the -CHO groups comprise at least about 10 mole percent of the X and Y groups; each M is independently a calcium or magnesium ion; each R is independently a hydrocarbyl group containing 1 to about 60 carbon atoms; m is 0 to about 10; n is 0 or 1 provided that when n is 0 the M is replaced with H; and each p is independently 0, 1, 2, or 3; provided that at least one aromatic ring contains an R substituent and that the total number of carbon atoms in all R groups is at least 7; and further provided that if m is 1 or greater, then one of the X groups can be -H;

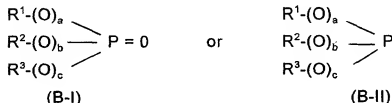
the lubricating oil composition being characterized by a sulfur content of about 0.01 to about 0.25% by weight.

20. A lubricating oil composition made by combining:

(A) a base oil;

(B) a phosphorus-containing compound represented by the

formulae

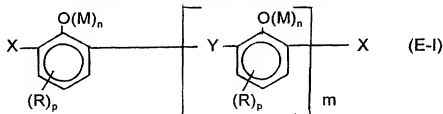


wherein Formulae (B-I) and (B-II),  $\text{R}^1$ ,  $\text{R}^2$  and  $\text{R}^3$  are independently hydrogen or hydrocarbyl groups, and  $a$ ,  $b$  and  $c$  are independently zero or 1;

(C) a polyisobutene substituted succinimide containing at least about 50 aliphatic carbon atoms in the polyisobutene group;

(D) a calcium or magnesium salt of an organic sulfur acid, a carboxylic acid, a lactone or a phenol;

(E) a compound represented by the formula



wherein in Formula (E-I): each X independently is  $-\text{CHO}$  or  $-\text{CH}_2\text{OH}$ ; each Y independently is  $-\text{CH}_2-$  or  $-\text{CH}_2\text{OCH}_2-$ ; wherein the  $-\text{CHO}$  groups comprise at least about 10 mole percent of the X and Y groups; each M is a calcium or magnesium ion; each R is independently a hydrocarbyl group containing 1 to about 60 carbon atoms;  $m$  is 0 to about 10;  $n$  is 0 or 1 provided that when  $n$  is 0 the M is replaced with H; and each  $p$  is independently 0, 1, 2, or 3; provided that at least one aromatic ring contains an R substituent and that the total

number of carbon atoms in all R groups is at least 7; and further provided that if m is 1 or greater, then one of the X groups can be -H; and

(F) a zinc dialkyl dithiophosphate;

the lubricating oil composition being characterized by a sulfur content of about 0.01 to about 0.25% by weight and a phosphorus content of about 0.02 to about 0.14% by weight.

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